Almost all about unit roots

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Book Review

ALMOST ALL ABOUT UNIT ROOTS: FOUNDATIONS, DEVELOPMENTS, AND APPLICATIONS, by In Choi. Published by Cambridge University Press, Cambridge, 2015. Total number of pages: 295.
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1 Introduction

Unit root tests are one of the building blocks of modern time series analysis because processes that may be characterized as having a unit root appear in many areas of science such as economics, finance, political science and sociology. Furthermore, the presence or absence of a unit root has a decisive effect on the methodology used in subsequent inference. For these reasons there have been an enormous number of papers studying unit root tests and their properties. In Choi's monograph accomplishes a monumental task: it delivers a comprehensive survey, an unabridged map of more than 30 years of theoretical research on the subject.

This review first outlines the book's content before providing a subjective assessment of its strengths and weaknesses. The book is a fitting member of the Cambridge University Press "Themes in Modern Econometrics" series which focuses on topics that students and researchers encounter daily and the emphasis is on pedagogic excellence and accessibility. Within this framework, the technicalities of the intricate mathematics used in deriving the limiting distributions of the tests are largely avoided by the author and emphasis is given on the underlying ideas and their implications to the practice of unit root testing.

2 Contents

The book contains seven chapters. Chapter 1 immediately motivates unit root testing as a method to either directly validate a theoretical hypothesis or as a first step before cointegration. Empirical examples are provided from many areas of science. Afterwards, the basic technical tools which are used for the derivation of limit theory, such as the Brownian Motion and the Functional Central Limit Theorem are briefly introduced.

Chapter 2 describes the basic methods of unit root testing. It starts with the asymptotic distribution of the ordinary least squares estimator in various models such as the AR(1) and the AR(p) with a unit root but also in the AR(1) model with roots near unity and in models with fractionally integrated errors. The basic unit root tests are presented such as the Dickey-Fuller and the Phillips-Perron tests. Naturally, once two tests are available the question which arises is which one is the more powerful of the two and so various findings in the literature regarding the power of these tests are analyzed. The chapter finishes with tests which were designed to have improved power such as the Dickey-Fuller-GLS test and the MAX test.

Chapter 3 covers more complex model specifications. It starts with the critical issue of unit root testing under structural breaks in mean, trend and variance parameters, which is frequently the case in economics. Conditional heteroscedasticity which appears in high frequency financial data is

next and then the chapter concludes with an analysis of unit root tests in the presence of outliers, fat tailed distributions and hypothesis testing against nonlinear alternatives such as threshold and smooth transition autoregressive processes.

Chapter 4 is concerned with alternative approaches to inference. Most of the previous tests where t-tests based on least squares or maximum likelihood estimators where the null hypothesis was the unit root case and the alternative was stationarity. The main topics here are bootstraping methods, which improve the finite sample properties of the tests, stationarity tests, against the alternative of a unit root, model free tests, which are robust to outliers and less model dependent, and finally, Baysian inferential methods.

Several topics which are related to unit root testing such as model selection criteria and methods of interval and point estimation for the AR model which may have a unit root, appear in Chapter 5. Furthermore, attempts to calculate the distributions of estimators and tests of the AR model with a unit root, are presented. The chapter closes with a discussion of the issue of how sampling frequency affects the power of tests.

Chapter 6 introduces unit root testing in seasonal processes. The exposition covers the popular HEGY test and then continues with its extensions. Some of them consider power improvement while others allow for structural changes. Seasonal stationarity tests are also covered.

The seventh and final chapter discusses panel data unit root tests. It starts with the first generation of panel tests which assume that the individual units are independent, an assumption not very realistic for macroeconomic panels, and then continues with second generation tests which allow for cross sectional dependence. Afterwards, panel stationarity tests are presented, as well as tests that allow for structural changes. Finally, the chapter describes the developments in the analysis of the power of panel unit root tests.

3 Strengths and Weaknesses

The greatest virtue of this book is in one word completeness. As a handbook or an encyclopedia of unit root testing it is the first place to go for every student or informed practitioner who has undertaken an empirical project. The book showcases the state of the art in the field; all major contributions are included and the theory behind every decision that needs to be made is well explained; and if there is no theory available, there are references to papers that did Monte Carlo simulations in order to investigate an issue. Every chapter is concluded with a "Summary and Further Remarks" section which provides the crux of the matter at hand and in many cases In Choi's authoritative views and experience on the subject.

The monograph is written very clearly throughout and the methodological exposition of results is based on the problem-solution paradigm. In every chapter a story unfolds detailing the problems of every test and how extensions deal with these problems. The presentation of results does not always follow the chronological order but is based on an internal subject consistency. Weight is given on intuition and ideas rather than mathematical proofs making the book very accessible. Furthermore, every chapter and section is self-contained which helps the reader concentrate on their interest rather than having to go through the previous chapters.

What this book does not help with is learning about unit root processes, i.e. it does not offer a pedagogical introduction like Hamilton (1994) or Patterson (2011). There is no discussion about trend and difference stationarity and no analytical exposition of the Functional Central Limit

Theorem. This is not a conventional textbook and the reader should already have an introductory course in time series analysis.

4 Conclusions

This treatise aims to provide a comprehensive and well organized survey of the literature on unit root testing. Overall, I think that it achieves this target. It is an excellent piece of scholarly work which is ideal for undergraduate and postgraduate students and for researchers in economics, finance and other sciences who wish to conduct empirical or theoretical research on unit roots. I would strongly recommend it to them.

References

[1] Hamilton, J. D., 1994. Time Series Analysis, Princeton University Press, New Jersey.

[2] Patterson, K., 2011. Unit Root Tests in Time Series Volume 1: Key Concepts and Problems, Palgrave MacMillan, Basingstoke

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